STANDARDIZATION OF THE DESIGN AND CONSTRUCTION OF AQUATIC COMPENSATION MEASURES

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ABSTRACT

For many years, the Ontario Ministry of Transportation has specified the protection and rehabilitation of, and compensation for impact to, the ecology of fish and aquatic habitat on a non-standard basis in construction contracts. Within the MTO’s five regions, excessive diversity of project-specific approaches and design was occurring.

What we found is that the continuous use of project-specific operational constraints and item specific mitigation and compensation measures has resulted in a proliferation of inconsistent, unproven and often expensive methods. This has left the Ontario Ministry of Transportation as owner, the regulatory agencies as approvers, as well as design consultants and construction contractors, all with a significant level of uncertainty in terms of design effectiveness, constructability and construction costs, and the chance of success and reproducibility of the ecological measures being used.

Furthermore, the Ontario Ministry of Transportation’s policy is to restrict the implementation of constructed aquatic ecological mitigation and compensation measures to land owned by the Ontario Ministry of Transportation, typically the highway right-of-way. This limitation places an increased importance on the proposed measures’ effectiveness and proper implementation.

The Ontario Ministry of Transportation’s current practices, methods and designs were analyzed and a constructability review was performed to determine the potential to standardize fish and aquatic habitat design and construction specifications and the need to update the associated guidance to designers.

This technical paper analyzes the effectiveness of the myriad of the Ontario Ministry of Transportation’s project-specific operational constraints and item specific mitigation and compensation measures and synthesizes these down to the critical few measures that can be implemented within the Ontario Ministry of Transportation’s land ownership and that provide the maximum benefit to the protection of aquatic ecosystems impacted by transportation infrastructure. The paper goes on to describe the process of standardization of design and construction protocols to ensure that those measures identified as standards can be implemented with certainty of effectiveness and cost.

We also explore where the standardized construction specifications have the potential to add other value to ecosystem preservation in the transportation infrastructure. We found that standardizing construction design and methodologies for ecological measures provides a basis for general contractors to understand the construction methodologies and rationale behind them which is envisioned to develop new construction skills within the contracting industry and promote the industry as a partner in transportation ecology.

The outcomes of this study produced a suite of Ontario Provincial Standard Specifications to provide for the protection and rehabilitation of fish and aquatic habitat for use in contract tender documentation and updated designer guidance and direction in the creation of contract design documentation.
In order to provide some context to this paper, it is important to understand the magnitude of the Ministry of Transportation of Ontario’s (MTO) jurisdiction and the policies and legislation that influence the intersection of the transportation network and fish and fish habitat bearing waterbodies in Ontario.

The Province of Ontario (Fig. 1) is home to a highway network consisting primarily of public highways owned and maintained by the Province. The MTO, as the responsible government agency, has a portfolio of over 16,600 kilometres (10,300 miles) of roadways organized into various classifications which are networked throughout the province to provide access to major population centres and rural towns and industries.

In particular, southern Ontario has a vast transportation system including many freeways. The freeway system in Southern Ontario is referred to as the 400 series highways. All freeways in Ontario are a minimum of four lanes in width, fully controlled with interchanges and directionally divided. The 12-lane segment of Highway 401 passing through Toronto is the widest and busiest freeway in North America, and one of the widest and busiest in the world. Highway 401 runs the entire length of Southern Ontario and is a key link to the economies of Canada and the United States of America, see Figure 2.
The Ontario transportation network connects to many international border crossings with the United States, including the Ambassador Bridge, the Blue Water Bridge, the Detroit–Windsor Tunnel, and the Sault Ste. Marie Bridge connecting Ontario with Michigan State, the Peace Bridge, the Rainbow Bridge, the Whirlpool Rapids Bridge, the Lewiston–Queenston Bridge, the Thousand Islands Bridge, the Ogdensburg–Prescott Bridge, and the Seaway International Bridge connecting Ontario and New York State, and the Pigeon River Bridge, the Fort Francis International Falls Bridge, and the Baudette-Rainy River Bridge connecting Ontario with Minnesota State.

In northern Ontario, which covers an area of 800,000 square kilometres, where vast distances separate communities and limit access to natural resources and major market areas, the King's highway system is a true social and economic lifeline. The MTO’s mandate as owner of this extensive portfolio is to:

- Be responsible for managing and maintaining province’s transportation system.
- Support economic growth by planning and investing in critical transportation infrastructure.
- Continue to build upon Ontario’s record as a leader in road safety.

As the MTO is the government agency responsible for Ontario's provincial highway program, the MTO sets design and maintenance standards and manages construction and maintenance activities on the provincial highway network. When delivering its transportation program, MTO does so with a view towards protecting the natural environment. The MTO must manage the
provincial highway program in compliance with federal and provincial environmental legislation and government policy. To this end, the MTO’s Environmental Policy Office develops policies and standards to support regulatory compliance and to provide for a consistent and systematic approach to environmental management.

The Environmental Standards and Practices documents provide the ministry's staff and its agents with the requirements, guidance and tools to protect the environment during all stages of highway management including transportation planning and highway design, construction and operations and maintenance. Some are also intended to support inter-agency protocols between the ministry and specific regulatory agencies such as the Ontario Ministry of the Environment and the Department of Fisheries and Oceans Canada.

The documents broadly include direction in the following areas:

1. A synthesis and interpretation of the extensive list of applicable requirements from environmental legislation, regulation and government policy;
2. The ministry's environmental assessment processes and procedures applicable to a range of environmental factors; and
3. The selection, design and implementation of environmental protection, mitigation and compensation measures.

**IMPORTANCE OF ONTARIO FISHERIES**

Freshwater fisheries are among Ontario's most valued natural resources. Protecting and restoring aquatic ecosystems not only means healthy fisheries but also healthier natural environments in general. Healthy aquatic ecosystems provide fishing opportunities, a nutritious food supply, and create employment. Ontario receives significant social, ecological and economic benefits from our fish populations and aquatic environments.

Canada is home to more lakes than the rest of the world’s combined total, and more fresh water than any other country. A variety of aquatic animals reside within these waters, and they are easily threatened by ongoing and/or expanding human endeavours.

The Great Lakes are home to more than 150 species of fish. On behalf of the people of Ontario, the Ontario Ministry of Natural Resources is responsible for protecting and managing fish in a sustainable manner for both present and future generations. To help guide both the day to day and long term management of Ontario’s fish, policies, procedures and guidelines have been established by the Ministry to guide the management and use of fish, fisheries and their supporting ecosystems.

Ontario is responsible for managing a large and diverse aquatic resource. The province manages 24% of Canada's freshwater, including 40% of the Great Lakes. There are over 250,000 lakes in Ontario and countless rivers and streams. Ontario boasts 20% of the world's lake trout lakes (approximately 2,000) and more than 3,500 walleye lakes. Even with this abundant resource, Ontario's fisheries are in high demand. Fish are a very important part of Ontario’s economy. They support the sport fishing and tourist industries, as well as commercial fisheries. About 1.27
million anglers fish in Ontario each year. These anglers spend over $2.5 billion dollars in the province annually.

**RELEVANT LEGISLATION AND POLICY**

The construction, maintenance and replacement of transportation structures at or near watercourses can have adverse effects on aquatic communities and their habitats. The *Fisheries Act* and the implementation of the 1986 Department of Fisheries and Oceans (DFO) "Policy for the Management of Fish Habitat" have strongly influenced the planning and implementation of transportation undertakings in Ontario.

Federal and Provincial legislation and policies have therefore been developed to ensure the valuable resources are protected. The *Constitution Act, 1982* gives the federal government of Canada the mandate to, among other things, oversee the *Fisheries Act*, which:

- Affects all territorial seas, inland water and fishing zones.
- Legally binding to all Canadians including provincial governments.
- Protects and manages fisheries.

The *Fisheries Act* is some of Canada's strongest environmental legislation and applies to all fishing zones, territorial seas and inland waters. It is binding on federal, provincial, and territorial governments. This legislation guides DFO in the administration of the habitat protection provisions of the *Fisheries Act*. This is the primary legislation governing fish and fish habitat which prohibits “harmful alteration disruption or destruction (HADD) of fish habitat and other provisions.

Section 35(1): General prohibition of harmful alteration, disruption or destruction of fish habitat

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*No person shall carry on any work, undertaking or activity that results in the Harmful Alteration or Disruption or Destruction of fish habitat*

HADD is “any change in the physical, biological or chemical attributes of habitat that adversely affect their ability to provide the basic life requisites of food reproduction and cover to fish”

- *Harmful Alteration:* Changes to a fish habitat that disrupt the life processes of fish, but does not destroy it.
- *Disruption:* Temporary changes to a fish habitat that disrupt the life processes of fish.
- *Destruction:* Permanent changes that destroy a fish habitat, and cease further production of fish.

The ultimate goal is to allow the productive capacities and/or populations of fish to continue to grow. The Fisheries Act provides the following definitions for two important terms used when dealing with fisheries:

*Fish:* includes "parts of fish, shellfish, crustaceans, marine animals and any parts of
shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals." (*Fisheries Act*, Sec. 2).

*Fish Habitat:* includes "Spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes." (*Fisheries Act*, Sec. 2(l)).

**DFO’S POLICY (1986)**

In 1986, Fisheries and Oceans Canada (DFO) implemented the *Policy for the Management of Fish Habitat* to support the habitat protection provisions of the *Fisheries Act* and introduces the guiding principle of No Net Loss of productive capacity and applies to all projects, large or small, that result in HADD guides the Habitat Management Program in the administration of the *Fisheries Act*. The policy objective is a Net Gain of productive capacity for fisheries resources. The three goals of the policy are as follows:

- Conservation (Guiding Principle of No Net Loss)
- Restoration
- Development/Enhancement

Under this guiding principle, DFO biologists work with the MTO to ensure their project proposals avoid harm or impacts to fish and fish habitat. If however, fish habitat losses are unavoidable, the productive capacity can be compensated by replacing or enhancing fish habitat once all the necessary mitigation measures have been applied.

In order to achieve the above mentioned goals the *Policy for the Management of Fish Habitat* defines mitigation and compensation.

Mitigation is defined as: “Actions taken during the planning, design, construction and operation of works and undertakings to alleviate potential adverse effects”.

Compensation is defined as: “Replacement of natural habitat, increase in the productivity of existing habitat ... where mitigation techniques and other measures are not adequate to maintain habitats” (i.e. replace lost productive capacity).

In certain cases, impacts from a project cannot be mitigated and fish habitat will be harmfully altered, disrupted or destroyed. In order to meet DFO’s guiding principle of no net loss of fish habitat a proponent must create habitat to offset the loss. In this case, DFO requires the proponent to create new habitat often referred to as compensation and has a hierarchy of preferred compensation options which include:

- Like for like on site
- Replacement off site
- Productive capacity improvements off site
In keeping with the guiding principle of *no net loss*, DFO will only issue Authorizations on the condition that measures to compensate for the HADD are implemented by the proponent. In other words, a compensation plan must accompany an application for an Authorization for HADD. Compensation measures are those actions intended to offset any residual adverse effects remaining after implementation of mitigation measures.

Compensation involves the replacement of damaged habitat with newly created habitat or the enhancement of existing habitat. DFO defines the compensation options that are available including in order of preference:

- Create or increase the productive capacity of like-for-like habitat in the same ecological unit;
- Create or increase the productive capacity of unlike habitat in the same ecological unit;
- Create or increase the productive capacity of habitat in a different ecological unit;
- As a last resort, use artificial production techniques to maintain a stock of fish, deferred compensation or restoration of chemically contaminated sites.

The hierarchy is based on the acknowledged uncertainty and difficulty in quantifying productive capacity. It assumes that there is a greater likelihood of achieving No Net Loss by maintaining/replacing the existing integrity, structure and functional attributes of the existing fish habitat to the extent possible. This also reduces the challenges associated with comparing pre and post-construction productive capacity.

Ecological unit is defined as: populations of organisms considered together with their physical environment and the interacting processes among them. Road allowances and property restrictions may prevent offsite habitat creation or enhancement from being viable compensation options for watercourse crossing and maintenance projects. However it is also possible to locate compensation sites elsewhere on the watercourse or adjacent watercourses that have been disturbed by other land use activities that would benefit from habitat creation or enhancement.

Adequate compensation for one project will not necessarily be adequate for a similar project on a different watercourse. Although the project may be identical, the fish species and habitat affected may be entirely different. For this reason, compensation measures should be applied on a project-specific basis and must take into account the biological and physical characteristics of the site.

Highway projects, such as linear facilities that commonly involve expansion of an existing facility, present unique challenges. The linear rights-of-way may cross a number of waterbodies, and constrain property availability and access. In contrast, existing highways often create unique opportunities to improve fish movement and habitat conditions, which can be of considerable benefit to the fish community. DFO also encourages this form of compensation. The latter opportunity is reflected prominently in MTO’s Compensation Hierarchy.

**ROLES OF VARIOUS GOVERNMENT AGENCIES**

MTO has the responsibility and accountability to self-screen their own projects of potential impacts resulting in the likelihood of a HADD. This is performed under the MTO/DFO/OMNR
Protocol for Protecting Fish and Fish Habitat on Provincial Transportation Undertakings (the “Fisheries Protocol”) which is an agreement between the Government of Canada as represented by DFO and the Government of Ontario as represented by the MTO and the Ministry of Natural Resources (MNR).

The Fisheries Protocol is a sub agreement to the 1987 Canadian Ontario Fisheries Agreement (COFA) which formally defines intergovernmental responsibilities for fisheries in Ontario, facilitates inter-agency coordination to minimize overlap and have access to shared resources. The Fisheries Protocol’s primary purpose is to define how the Fisheries Act will be administered for MTO undertakings, as it applies to all MTO projects and all fish and fish habitat within the Province of Ontario. The Fisheries Protocol is intended to facilitate a collaborative approach in increasing certainty, consistency, efficiency and effectiveness in the conservation, protection and restoration of fish habitat on provincial transportation undertakings in the Province of Ontario through the implementation of federal and provincial legislation, regulations, policies and programs identified herein.

The Fisheries Protocol must also work hand-in-hand with the MTO technical environmental standards and practices. As such, MTO developed the Environmental Guide for Fish and Fish Habitat under the direction of the environmental standards project. The Environmental Guide for Fish and Fish Habitat (the “Guide”) was developed to assist the implementation of the Protocol. The finer points on following the Protocol process are provided in Section 2. The subsequent sections provide guidance on: methods to collect background and field; assessment of these data, and a decision-making framework that parallels current DFO guidance documents. The Guide also includes technical guidance on mitigation and compensation approaches and practices.

Given that MTO is also responsible for the development of mitigation measures, including design modifications, to eliminate or reduce the risk of HADD. Where HADD is unavoidable, MTO develops project specific “compensation” plans. Fish habitat “compensation” as the result of losses attributed to transportation infrastructure involves the “replacement of natural habitat, increase in the productivity of existing habitat where mitigation techniques and other measures are not adequate to maintain habitats” (Fisheries and Oceans Canada 1986). The purpose of compensation is to balance unavoidable habitat losses with habitat replacement, to achieve the guiding principle of No Net Loss of productive capacity, as stated in the Policy for the Management of Fish Habitat).

THE ONTARIO PROVINCIAL STANDARDS

Standards and standardization have existed in our world for a long time. Standardization in our present day industrial world is a powerful force helping to simplify production procedures. Standardization can limit the unnecessary variety of products and components. Duplication is reduced with resulting cost savings and without reduction in quality. The push towards greater standardization in transportation design has come from a number of sources, but the contracting associations have often pointed out areas where there is a lack of standardization or where there are too many standards in use by different authorities for virtually the same purpose.

The Ontario Provincial Standard Specifications (OPSS) are produced as a result of recommendation of the Municipal Project Liaison Committee Report of July 1977. After six
years of discussions, reviews, and standards development, the Ontario Provincial Standard Specifications were published for the first time in January 1984. Since that time, the standards have been reviewed and revised on an ongoing basis, and new standards have been added as users identify the need.

The OPSS organization is co-owned by the Municipal Engineers Association (MEA) and the MTO. Working with other private and public associations, the co-owners maintain the standards through a structure of committees. OPSS are revised and developed by nine OPSS specialty committees through consensus. Membership on the committees is made up of professional and technical individuals, who volunteer their time and are supported by the organizations for which they work, to represent the OPSS owners and partners.

The purpose of using the Ontario Provincial Standard Specifications is to:

- Consistent and cost effective for owners and contractors.
- Easy to read and understand; clear and concise.
- Reduce contract preparation time.
- Maximize return on infrastructure investment.
- Quality standards and products list.
- Standards and product lists updated by practitioners and experts.

PROBLEM STATEMENT

For many years, the MTO has specified the protection and rehabilitation of, and compensation for impact to, the ecology of fish and aquatic habitat on a non-standard basis in construction contracts. Within the individual MTO’s five regions there was an overarching desire for parochialism, which led to an excessive diversity of project-specific approaches and design.

MTO’s continuous use of project-specific operational constraints and item specific mitigation and compensation measures has resulted in a proliferation of inconsistent, unproven and often expensive methods. This has left the MTO as owner, DFO the regulatory agency as approver, as well as consultants and contractors as designers and installers, all with a significant level of uncertainty in terms of design effectiveness, constructability and construction costs, and the chance of success and reproducibility of the ecological measures being used.

Furthermore, the MTO’s policy is to restrict the implementation of constructed aquatic ecological mitigation and compensation measures to land owned by the MTO, typically the highway right-of-way (ROW). This limitation places an increased importance on the proposed measures’ effectiveness and proper implementation.

MTO typically uses “general” contractors for the construction as they are unionized, yet have limited skill in constructing fisheries compensation measures. Ontario has a few specialised contractors, however not all of these contractors are unionized which poses a problem for these specialized contractors to be utilized by the general contractors.

MTO is also required under a DFO Fisheries Act Authorization to monitor the effectiveness of compensation measures on an annual basis for two years following construction without any
mechanism in place to provide feedback also contributing to the uncertainty in the compensation measures being employed to date.

**DESIRED OUTCOME OF THE STUDY**

MTO needed to test whether standardized compensation measures could provide designers with sufficient guidance on the general design and suitability of each measure, as well as considerations for implementation including:

- Up-to-date with current environmental practice and MTO business practices,
- User friendly specifications and designs to direct non-specialized contractors,
- Consistent, cohesive, effective regardless of the geography,
- Approached that are effective and that benefit the provincial fisheries resource,
- Accessible to and usable by MTO, MTO’s agents and Regulatory Agencies, and
- Updateable and something that can be built upon over time.

Morrison Hershfield was engaged to develop a research study to inform the Ministry of the feasibility of developing standards for the implementation of aquatic compensation measures to alleviate the uncertainty in terms of design effectiveness, constructability and construction costs in addressing the issues at hand. MH designed a project protocol that analyzed the effectiveness of the myriad of MTO’s project operational constraints and item specific mitigation and compensation measures developed throughout the province over the last ten to fifteen years. With a focus on providing the maximum benefit to the protection of aquatic ecosystems affected by transportation infrastructure, the critical measures that can be implemented within the MTO’s ROWs were identified.

**STUDY METHODOLOGY**

Morrison Hershfield’s primary objective was to analyze current MTO practices, methods and designs and perform a constructability review to determine the potential to standardize aquatic habitat design and construction specifications. We reviewed over two hundred project-specific designs and construction methodologies from across the province to identify high frequency aquatic compensation measures that held the potential to meet the MTO’s desired outcome for design and implementation certainty and that met the requirements to establish a net benefit under the *Fisheries Act*.

Of the project specific measures reviewed and measures with the potential for standardization confirmed, the next objective was to identify the critical few measures that could be implemented within the MTO’s right-of-ways that provide the maximum benefit to the protection of aquatic ecosystems impacted by transportation infrastructure. Those critical few measures needed to be able to be implemented across all of MTO’s geographical regions to eliminate the diversity of approaches currently found across the province. Those critical few measures identified are listed in Table 1.
### TABLE 1 List of critical fish habitat compensation measures.

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<tr>
<th>Sub-Section</th>
<th>Measure</th>
<th>OPSS</th>
<th>OPSD</th>
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<td>3.3.1</td>
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<td><strong>Bio-Engineering Techniques</strong></td>
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<td>Brush Layer</td>
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<td>Native Sod Mats</td>
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<td>D222.070</td>
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<td><strong>Fish Passage Improvements, Barrier Removal or Culvert Retrofit</strong></td>
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<td>3.3.9</td>
<td>Low Flow Channels</td>
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<td>3.3.12</td>
<td>Baffles</td>
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<td><strong>Woody Structure and Bank Stabilization in a Waterbody</strong></td>
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<td>Rootwads</td>
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<td><strong>Enhancement of Morphological Elements using Natural Channel Design</strong></td>
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At this point in the study, the regulatory agencies of DFO and MNR were engaged to present the critical few measures proposed to be standardized to address aquatic compensation planning on transportation projects. Having gained their support for the proposed measures, the next step was to standardize the measures using the OPSS format and to create typical drawings of the measures in the Ontario Provincial Standard Drawing format.

Following the creation of the OPSS and OPSD, it was apparent that existing MTO guidance documentation, such as the *Environmental Glossary* and the *Environmental Guide for Fish and Fish Habitat*, required amendments to ensure consistent language and that the newly prescribed guidance for designers of aquatic compensation reflected the new standards.
STUDY OUTCOMES

The outcomes of this study produced a new suite of Ontario Provincial Standard Specifications and Ontario Provincial Standard Drawings to provide for the protection and rehabilitation of fish and aquatic habitat as listed in Table 1. These will be used in contract tender documentation and provide designer guidance and direction in the creation of contract design documentation. They are currently in the process of being formally documented as OPSSs and OPSDs for use by the end users.

The OPSSs and OPSDs provide compensation measures and design guidance for the creation and installation of woody cover/structure in-stream or in a waterbody which can be used to provide spawning and nursery habitat for target species such as northern pike, or walleye and smallmouth bass, respectively. These habitats can also function to provide seasonal or permanent refuge and production habitats for a variety of warm and cold water species including nursery and rearing habitat for larger species, and habitat generally for production of a variety of forage species.

Many of the measures relate to creation or enhancement of specific habitat elements. For example, Pool (Inlet/Outlet) OPSS D834 can be of particular benefit to fish in seasonal systems, or to provide seasonal refugia for cold water species. Provision of cover elements can benefit a variety of species and life stages. These techniques should again be selected in specific consideration of compatibility and benefit in relation to the target fishery and the waterbody processes.

The completed research and analysis and the ultimate development of the new and unprecedented suite of OPSSs and OPSDs for maintaining environmental quality, has provided the MTO with the ability to increase the effectiveness of their aquatic compensation projects through clear design guidance and certainty in construction specifications and methodologies. Sample OPSDs and representative drawings with associated photos are included in Appendix 1.

Aquatic habitat compensation involves the replacement of natural habitat, an increase in the productivity of existing habitat where mitigation techniques and other measures are not adequate to maintain habitats. Taking that into consideration, this project certainly serves to strengthen the MTO’s commitment to these national policies on environmental quality through the standardization of effective measures that achieve this fundamental purpose. Functional, natural environments are important values that society holds in high regard. It is this subjective perception of society that the environment is being considered and protected that is addressed by this project. In the balance between the need for transportation infrastructure and the protection of environmental quality, society gains an increased understanding that the quality of their environment is important to those entrusted with its protection.

In an economic environment where the engineering industry is being looked to provide effective, constructible solutions at a frugal cost, standardized design and construction direction is the inaugural step in achieving this economic goal. Balance this need with the expectation of society that the natural environment will not be ignored in the name of infrastructure development and
the outcomes of this project serve to provide a framework where all of these integrated needs are
addressed for many years to come.

INNOVATIVE DESIGN APPROACH

The study team retained R&M Construction Limited to be a key part of our technical team. In
doing so, the team was able to engage in a learning environment and knowledge transfer between
owners, technical designers and construction contractors which added incredible value to the
project outcomes. This innovative and integrated approach to bringing people together who
normally do not sit at the same table during the development of design methodologies was truly
an exercise in thought leadership between the MTO and the study team.

The entire concept of producing OPSSs for aquatic compensation measures was an exercise that
has never been undertaken before. The success of this innovative approach is exemplified by the
MTO receiving outstanding support from their stakeholders, including the Ontario Ministry of
Natural Resources and Fisheries and Oceans Canada, for the ultimate roll out of these
standardized measures. Having a suite of aquatic compensation measures that have been
essentially “pre-approved” by the regulatory agencies is in and of itself an innovative approach
to minimizing regulatory hurdles during a project’s planning cycle.

The development of specific construction methodologies captured in the OPSSs will transfer
knowledge to general construction contractors. Save for a few specialist contractors who engage
in aquatic compensation construction, this has not typically been an expertise readily available
within the general contracting industry. Standardizing construction design and methodologies for
ecological measures provides a basis for general contractors to understand the construction
methodologies and rationale behind them. This is envisioned to develop new construction skills
within the general contracting industry and promote the industry as a partner in transportation
ecology.

STUDY CHALLENGES

The creation of a standardized approach to aquatic compensation measures across the province is
quite challenging, particularly since it had not been done before. As stated previously, excessive
diversity of project-specific approaches was occurring across the province. The study team
analyzed project-specific operational constraints measures, synthesizing them down to the
critical few measures that best meet MTO’s objectives of providing effective compensation
measures with increased certainty in implementation and cost.

A further challenge was that these standardized measures would need to be accepted by the
stakeholders and regulatory agencies as appropriate and effective aquatic compensation for
habitat losses on transportation projects. The creation of OPSSs presents an extremely high level
of complexity in terms of the contractual language created by these documents that will
ultimately form part of a legal construction tender. The editing of these documents to ensure that
pre-existing OPSSs were properly cross-referenced, that the language used provided clear and
concise direction to the user, and that ultimately the users of these documents would be able to
create the intended aquatic compensation measures with ease and clarity was a significant project challenge.

**POST-STUDY ACTIVITIES**

Since the development of the standards, MTO, has been receiving outstanding support from their stakeholders, including Ontario Ministry of Natural resources, and Fisheries and Oceans Canada for the roll out of the new design criteria, construction specifications and typical designs. This initiative built on true industry collaboration and the integrated outcomes will have a long lasting legacy for the natural environment.

The creation of OPSSs that the entire design and construction communities in Ontario will use going forward, is a fundamental achievement of technical excellence and has been recognized with the 2013 Award for Technical Merit by the Consulting Engineers of Ontario.

Design guidelines have been improved with the direct support of the construction industry’s best practices, truly making them a true partner in transportation ecology. The anticipated benefits to the natural environment may only be fully appreciated in the years that follow, not only in the province of Ontario, but also in other jurisdictions where these findings may also have an influence.

**BIOGRAPHIES**

Dr. Paul Draycott is currently Vice-President of the Environmental Global Business Unit and General Counsel with Morrison Hershfield. He is a Canadian Certified Environmental Practitioner in the fields of Environmental Protection & Management, Environmental Policy & Legislation, Fisheries & Wildlife, and Energy. Paul was formerly a practicing environmental lawyer, owned and operated a leading edge environmental consulting firm, and held high profile positions with the Ontario Public Service at the Ministry of Natural Resources. Paul’s unique marriage of environmental planning and biophysical technical skills with environmental legal and regulatory expertise allows Paul to provide senior environmental leadership on high profile, complex undertakings. Paul’s environmental legal experience reviewing and advising on proposed environmental legislation, including from the commercial perspective of the end user, coupled with work developing environmental standards and policy, allows Paul to bring an extensive, working understanding of public and private sector issues to the development of environmental programs, policy and legislation. Paul has over 32 years’ experience managing and working on multi-disciplinary engineering, environmental and social impact assessment, environmental management plan development, natural habitat inventory and impact assessment projects across North America in the transportation, mining, energy generation and transmission, oil & gas, industrial and land development sectors.

Ms. Brenda Carruthers is a long time employee of the Ontario Ministry of Transportation. Having spent most of her 27 year career in the Environmental Policy Office at MTO, she has an extensive background in environmental legislation and policy development relating to transportation planning, design, construction, operation and maintenance, for a variety of environmental factor areas and policy vehicles. Her main areas of policy expertise have included
waste/spills/contaminated property management, fisheries, erosion and sediment control and wildlife mitigation. Several years ago she led a multi-year, multi-disciplinary assignment called the Environmental Standards Project to update and add to MTO’s suite of technical policy documents to support the environmental assessment process for transportation facilities. Brenda has served on the Ontario Provincial Standards for Roads and Public Works - Environmental Committee for many years and is currently Chair of the committee. She has considerable experience with contract documentation development and standardization to ensure consistent integration, application and administration of environmental requirements on construction contracts.

Ms. April Marton is employed with the Ontario Ministry of Transportation working in the Environmental Policy Office as a Senior Policy Analyst on the fisheries portfolio, monitoring developments in provincial and federal policy and legislation; analyzing implications for MTO programs; and recommending areas for policy development. Prior to that April worked in the Central Region Provincial Highways Management Program as a Senior Planner of Fisheries and Wetlands overseeing the fisheries portfolio for the major capital construction program using her advanced expertise and in-depth knowledge of fish habitat restoration and enhancement techniques in developing innovative and cost effective solutions to avoid, mitigate and if required compensate for the loss of fisheries habitat. April has over 15 years of experience leading, coordinating, organizing and planning environmental programs and projects, effectively working with current political, social and developmental issues, conducting environmental assessments and reviews, managing financial, human and natural resources while working on many multi-disciplinary engineering, environmental projects both in the private and public dealing with fish and wetland assessment, policy, construction, planning, permitting applications and design projects of compensation. This level of experience has allowed April to provide senior environmental leadership on high profile and complex undertakings.

Ms. Josephine Gilson has considerable experience in environmental protection and management, aquatic and terrestrial ecosystems, and environmental regulatory legislation. Her experience includes the development of large scale environmental management plan documents dealing with all facets of the regulatory requirements including developing monitoring and follow-up plans to ensure the mitigation strategies are effective. Cumulative effects assessment strategies as well as requirements for monitoring impacts on the land are included in the development of these documents. Josephine also has considerable experience in developing environmental programs for fisheries assessments, terrestrial assessments and groundwater and surface water investigations. Josephine not only plays a key role in developing these programs, but she also completes the associated field work, data input, analysis, and technical reporting. Specific programs have included: aquatic habitat assessments; aquatic impact assessments; terrestrial habitat investigations; bird habitat surveys; and groundwater and surface water monitoring programs.

Mr. Harry Reinders is the President and owner of R&M Construction Limited, a specialized contracting company in the creation of aquatic habitats and sediment and erosion control solutions. Harry has over 35 years in the construction of soil erosion protection including bank stabilization, channel improvements, flood control measures and shoreline protection and he has completed many projects implementing the latest in bio engineering and fluvial geomorphologic
concepts. Harry has had the opportunity to construct, restore and create new parklands and trails as well as stream and wetland construction & restoration. Harry specializes with projects involving difficult accessibility and/or unique environmental concerns and he has built the trust of Ontario regulatory authorities, including the Ministry of Natural Resources, city parks/public works departments personnel and Department of Fisheries and Oceans, through his ability to provide solutions to challenges encountered in the field during construction.
APPENDIX 1: SAMPLE OPSDs AND REPRESENTATIVE DRAWINGS WITH ASSOCIATED PHOTOS
This specification covers the requirements for the construction of rocky ramps for the enhancement of fish passage over in-stream barriers. This specification applies to the work associated with constructing rocky ramps without limiting the conditions and approvals imposed by statute.

**D XXX.01.01 Specification Significance and Use**

This specification is written as a provincial-oriented specification for the enhancement of fish passage. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

**D XXX.02 REFERENCES**

The Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.
This specification refers to the following standards, specifications, or publications:

**Ontario Provincial Standard Specifications, General**

OPSS 182  Environmental Protection During Construction in Waterbodies and on Waterbody Banks
OPSS XXX  Temporary Flow Control

**Ontario Provincial Standard Specifications, Material**

OPSS 1010  Aggregates - Base, Sub-base, Select Subgrade, and Backfill Material

**Ontario Provincial Standard Specifications, Construction**

OPSS XXX  Low Flow Channels

**Other**

MTO Environmental Guide for Fish and Fish Habitat, 2012

**D XXX.03  DEFINITIONS**

For the purpose of this specification, the following definitions apply:

Deleterious Substance means as defined in OPSS 182.

Riffle Stone Mixture means a stone mixture used to create the downstream slope of a riffle.

Low Flow Channel means as defined in OPSS XXX.

Stream Bed means the material that is on the bottom of the channel where a waterbody flows.

Stream Bed Material means as defined in the MTO Environmental Guide for Fish and Fish Habitat.

Waterbody means as defined in OPSS 182.

**D XXX.04  DESIGN AND SUBMISSION REQUIREMENTS**

Where rocky ramps are installed in the dry, the design and submission requirements for temporary flow control shall be according to OPSS XXX.

**D XXX.05  MATERIALS**

All materials shall be free of deleterious substances.

**D XXX.06  EQUIPMENT**

Equipment shall include the use of an excavator that is equipped with a smooth edge, swivel bucket with a thumb attachment. The excavator shall use a ¾ to 2 yard bucket that is sized appropriately for the project.

**D XXX.07  CONSTRUCTION**

D XXX.07. 01 Installation
Rocky ramps shall be installed in the dry.

Where feasible, any pre-existing, permanent obstructions shall be removed from the waterbody according to the Contract Documents.

The stream bed shall be graded to create the slope as defined in the Contract Documents. Following the construction of the designed slope, riffle stone mixture shall be installed on the stream bed to create riffle-pool sequences and graded as per the Contract Documents.

A low flow channel shall be constructed according to the Contract Drawings and according to OPSS XXX Construction Specification for the Installation of Low Flow Channels.

After the flow of water has been re-instated to the waterbody according to OPSS XXX, the Contractor shall adjust the riffle stone mixture placement by hand to achieve the design according to the Contract Documents.

The Contractor shall monitor the rocky ramp after installation is complete and verify that the grade and transition to the natural channel does not present any barriers to flow or direct flow outward to the banks. The Contractor shall adjust the placement of the riffle stone mixture to rectify any of these conditions.

**D XXX.09 MEASUREMENT FOR PAYMENT**

**D XXX.09.01 Actual Measurement**

**D XXX.09.01.01 Rocky Ramps**

The measurement of rocky ramps shall be by linear metre, in place.

**D XXX.09.01.02 Stream Bed Material and Granular B Aggregate**

Measurement of stream bed material and granular B aggregate shall be by volume in cubic metres (m$^3$).

**D XXX.10 BASIS OF PAYMENT**

**D XXX.10.01 Rocky Ramp – Item
Stream Bed Material – Item
Granular B Aggregate - Item**

Payment at the Contract price for the installation of rocky ramps, stream bed material and granular B aggregate shall be full compensation for all labour, Equipment, and Material to do the work.
CONSTRUCTION SPECIFICATION FOR
ROOTWADS AS FISH HABITAT

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D XXX.01  SCOPE

This specification covers the requirements for the installation of rootwads to provide bank stabilization and improve fish habitat.

This specification applies to the work associated with installing rootwads without limiting the conditions and approvals imposed by statute.

D XXX.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification for the enhancement of fish habitat and bank stability. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

D XXX.02  REFERENCES

The Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.
This specification refers to the following standards, specifications, or publications:

**Ontario Provincial Standard Specifications, General**

OPSS 182 Environmental Protection During Construction in Waterbodies and on Waterbody Banks  
OPSS XXX Temporary Flow Control

**D XXX.03 DEFINITIONS**

For the purpose of this specification, the following definitions apply:

**Anchoring Stone** means as defined in this specification.

**Trunk** means the trunk of a tree.

**Footer Log** means as defined this specification.

**Normal Water Level** means as defined in OPSS 182.

**Rootmass** means the root mass at the end of the trunk.

**Waterbody** means as defined in OPSS 182.

**D XXX.04 DESIGN AND SUBMISSION REQUIREMENTS**

Where rootwads are installed in the dry, the design and submission requirements for temporary flow control shall be according to OPSS XXX.

**D XXX.05 MATERIALS**

**D XXX.05.01 Rootwads**

A limbed tree with a durable wood such as oak, maple, cedar, spruce, pine, tamarack, or beech are all acceptable for a rootwad. The tree must have an intact rootmass approximately 1 to 2 m in diameter, and the trunk must be 2 to 3 m in length. All soil and debris shall be removed from the rootmass. Trees may be sourced on-site, as removals under the Contract design, or may be sourced off-site. Tree removal shall be excavated by heavy equipment to maintain the rootmass.

**D XXX.05.02 Footer Logs**

Natural, untreated logs shall be used as footer logs for the rootwads. The footer logs shall be 25 to 45 cm in diameter, and 2 to 4 m in length. The footer log shall be oak, maple, cedar, spruce, pine, tamarack or beech.

**D XXX.05.03 Anchoring Stone**

Anchoring stones are large boulders that are field stone or quarried bedrock and are a minimum 1 ½ times the diameter of the trunk of the rootwad. All stone must be free of deleterious substances.

**D XXX.06 EQUIPMENT**
Equipment shall include the use of an excavator that is equipped with a smooth edge, swivel bucket with a thumb attachment. The excavator shall use a ¾ to 2 yard bucket that is sized appropriately for the project.

Hand tools such as shovels, picks and saws will also be required.

### D XXX.07 CONSTRUCTION

#### D XXX.07.01 Installation

Following the dewatering of the installation site, if the installation is to be completed in the dry, the installation of rootwad(s) shall be completed in the following sequence.

a) Excavate the bank to accommodate the rootwad trunk which will be embedded into the bank up to the rootfan. The excavation shall be slightly angled to become deeper further inland from the edge of the watercourse.

b) Install the footer log so that it sits at the waterbody’s edge of the excavation, parallel to the bank, and at the depth specified in the Contract Documents. Where more than one rootwad is to be installed in series, install the footer logs starting at the downstream end of the installation.

c) Place the rootwad trunk in the excavation resting on the footer log. Angle the trunk slightly in the excavation so that the rootwad is facing upstream at approximately 30 to 40° angle from the bank. One third of the rootfan diameter shall be installed below the normal water level.

d) Install anchoring stone on the trunk and footer log to secure the structure in place, as per the Contract Documents. The stone should cover the length of the trunk and the footer log so that neither is visible.

e) Place the excavated material from the bank over the anchoring stone and grade according to the Contract Documents.

### D XXX.09 MEASUREMENT FOR PAYMENT

#### D XXX.09.01 Actual Measurement

#### D XXX.09.01.01 Rootwad & Footer Log

Measurement of rootwads and footer logs shall be by each, in place.

#### D XXX.09.01.02 Anchoring Stone

Measurement of anchoring stone shall be by volume in cubic metres (m$^3$).

### D XXX.10 BASIS OF PAYMENT

#### D XXX.10.01 Rootwad – Item

#### Footer Log – Item

#### Anchoring Stone - Item

Payment at the Contract price for the installation of rootwads, footer logs and anchoring stone shall be full compensation for all labour, Equipment, and Material to do the work.
Please note that all photographs are the property of Morrison Hershfield Limited. OPSD drawings are the property of the Ministry of Transportation of Ontario. We are permitted by MTO to reproduce the drawings in this report.

OPSDs for riparian and wetland plantings, shown in a re-aligned channel in Purpleville Creek, Highway 400
Photo illustrates OSPD measures of Woody Debris Cover Structures and Riffle on Purkleville Creek, Highway 400
Constructed pool with rootwad compensation measures in Rabbit Creek, Ontario
Low Flow Channel and Rock Baffle implemented under an MTO Highway 6 bridge